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OFFICE OF SPACE SCIENCES

SPACE SCIENCE ADVISORY COMMITTEE

Jet Propulsion Laboratory, Bldg 180, Room 141
Pasadena, California

March 3-5, 2003

MEETING REPORT

Dr. Marc S. Allen	**Dr. Andrew B. Christensen**
Designated Federal Official	**Chairman**

Space Science Advisory Committee (SScAC)

Jet Propulsion Laboratory, Bldg 180, Room 141
Pasadena, California
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Space Science Advisory Committee

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Monday, March 3

Welcome

The Director of the Jet Propulsion Laboratory (JPL), Dr. Charles Elachi, welcomed the Space Science Advisory Committee (SScAC) to JPL. Dr. Elachi elaborated on the new JPL Mars spacecraft to be launched in June at the Cape. With these two, JPL will have 18 spacecraft in flight. Goddard has just as many. This is the first time in NASA's history to have that many in space.

Chair's Opening Remarks

Dr. Andrew Christensen, Chair of the SScAC, called the meeting to order, welcomed members and attendees, and made introductions. He introduced Dr. David N. Spergel, Department of Astrophysical Sciences, Princeton University, who will be replacing Dr. Dressler as a committee member and chair of the Origins Subcommittee as soon as the approval process is completed. Dr. Christensen informed the group that this meeting was to be recorded. He then recognized Dr. Marc Allen, the SScAC Designated Federal Official, who reviewed the meeting logistics. Dr. Allen clarified that this will not be a live broadcast. It is scheduled to be up and posted on the NASA web site 14 days after the meeting.

Dr. Allen informed the group that this Committee's subcommittees' charters have not been filed with the Government Services Administration (GSA). Consequently, according to the Federal Advisory Committee Act, they are not legally advisory committees. Therefore, they can only advise this Committee and not NASA directly.

FY04 OSS Budget Presentation

Dr. Edward J. Weiler, Associate Administrator for Space Science, presented program highlights of the Office Space Science (OSS) prior to his FY04 OSS budget presentation. Most exciting among the highlights were some from the Wilkinson Microwave Anisotropy Probe (WMAP), which lead to some of the most significant scientific discoveries of recent years. Highlights from various missions:

- First stars to shine in our universe ignited only 200 million years after the Big Bang.
- Age of the universe is 13.7 million years.
- There is abundant water ice on Mars in high latitudes.
- Mars is a planet layered by sedimentary processes.
- Hubble Space Telescope (HST) made the first detection of atmosphere on an extrasolar planet.
- RHESSI and TIMED completed the first tracing of the flow of energy from the Sun's flares to Earth equatorial plasma depletions that disrupt communications.

Dr. Weiler then made a presentation on the President's FY04 budget request. In FY95, OSS's budget was moving downward; however, by FY98, the budget was on the up swing. Starting in FY2002, NASA switched to full cost accounting. By October 2004, NASA will have completed the move to full cost accounting, which will include costs for personnel, infrastructure, building, road, space shuttle, etc. This conversion has been an extensive effort. In 2008, OSS, will be about one-third of NASA's budget, while human space flight, will remain level.

Within the OSS full-cost FY04 President's budget (OSS), Solar System Exploration (minus Mars and the Sun) was allocated 34 percent ($1,358.8 million) of the budget. This includes nuclear power, optical communications, and the Jupiter Icy Moons Orbiter (JIMO). Mars Exploration accounts for 14 percent

($570.2 million) of the budget, Sun-Earth Connection (SEC) for 19 percent ($769.6 million), Structure and Evolution of the Universe for 11 percent, Astronomical Search for Origins for 22 percent ($876.9 million). Dr. Weiler pointed out that SEC is growing rapidly. SEC accounts for money for Explorers until a project's budget is assigned to the office that will control it, so the future Explorers line is artificially high. Overall, space science will increase by 60 percent over the next 5 to 6 years.

It will be difficult to do full cost management because of the civil service. It is almost impossible to reduce personnel levels; therefore it will not be true cost management. If we could transfer people easily, than we could have true full cost management. Dr. Weiler thought that in 5 years we will be able to be more flexible with transferring personnel.

Dr. Weiler explained the NASA budget review process, noting the many inputs to the final product. The process is starting now for the FY05 budget and will end in December. Under Mr. O'Keefe, NASA is intended to become a science-driven program, not a technology program.

A few years ago, NASA was told to do small projects. The science community has expressed the need and desire also for larger missions. Consequently, NASA has moved to larger projects. Ten years ago, it was thought that smaller was faster, better, cheaper. We have found that it is not necessarily true that smaller is better.

In addition, there has been a shift to outcome performance measurement—what questions do we have and how are we going to get the answers. These results-oriented questions and responses have been instrumental in getting more money for our efforts. It is a much more effective method than using general statements that science is wonderful. OSS led the way with this. The Mars program got the highest rating of all the programs evaluated in the PART OMB exercise. Dr. Weiler relayed his congratulations to Mr. Figueroa and the Mars team.

2004 Initiatives– New Content

Dr. Weiler continued his presentation with descriptions of the new OSS initiatives. The first initiative is Project Prometheus. Two existing programs were combined–the Nuclear Systems Initiative (NSI) and the Jupiter Icy Moons Orbiter (JIMO) mission–into this new Project Prometheus initiative. The project cost will be between $3 and $9 billion. OSS convinced OMB not to designate a specific dollar number for the project until we are into the program for a couple years. With the Hubble telescope, we really did not know what it would cost until we began working on it. It ended up costing $5 billion; in 2010 dollars that is $10 billion.

Project Prometheus

Project Prometheus will enable more robust scientific missions by developing nuclear power to power spacecraft. The nuclear power will enable:

- Significantly larger and faster data communications networks
- A single spacecraft to visit multiple targets per mission
- Eliminate dependence on gravity assists.

JIMO is the first application of nuclear power and propulsion technologies to a flight mission. JIMO will provide 180 days of observations as compared to 1 to 5 hours of observation that we currently get. The power available currently is equivalent to 2 or 3 light bulbs; with nuclear power, it will be the equivalent of a stadium light. The current amount of science data return is equivalent to 1 – 2 floppy disks; with nuclear power, it will be the equivalent of 120 CD-ROMs.

This mission will search for evidence of global subsurface oceans on Jupiter's three icy moons: Europa, Ganymede, and Callisto. JIMO responds to the National Academy of Sciences' (NAS) recommendation that a Europa orbiter mission be the number one priority in Solar System exploration.

Dr. Weiler reported that the first nuclear power plant would cost a lot of money, between $1 and $2 billion. Subsequent costs, however, will be greatly reduced. Nuclear power will give an enormous boost in power; as a result we are issuing a NRA asking for new concepts for using this power. A cross-disciplinary group of scientists will review the proposals.

NASA is working with all the agencies that are working with nuclear power, including DOE for their experience in design, manufacture, and safety. NASA will fully comply with environmental and nuclear safety launch approval processes for use of nuclear power systems in outer space.

Optical Communications

The second initiative is an optical (laser) communications program, which will enable a revolutionary volume of data to be returned for lower cost per byte. It is time for NASA to adapt this technology for our missions, now that private companies and DoD have spent billions developing the technology. The high-resolution camera on MRO will image <0.1% of the planet after 1 Mars year due to limitations of the communication link back to Earth: ~2.2Mbps at closest range and 0.3 Mbps at maximum range. Optical communication could link back to Earth at ~10Mbps at closest range and 1Mbps at maximum range. Plus, data return from outer planets has the potential to be improved by an order of magnitude or better.

Beyond Einstein

Lastly, we will obtain development funding for three key elements of the Beyond Einstein program: Constellation X, LISA and Einstein Probes. Thus, the budget includes funding for all the programs we conceived of in the 1990's, and OMB has asked for funding to initiate "Einstein Probes," a program that will begin later this decade. This program will consist of openly competed missions to conduct investigations that future the Beyond Einstein science objectives.

2003 Space Science Launches

The presentation continued with the identification and discussion of the major NASA space science launches in 2003. They are:

- CHIPS– launched from VAFB Jan 12
- GALEX –Scheduled from CCAFS March 25
- SIRTF –Scheduled from CCAFS April 15
- Mars Exploration Rover A –Scheduled from CCAFS May 30— This is a mobile geology lab looking for signs of water in the past.
- Mars Exploration Rover B –Scheduled from CCAFS June 25
- Gravity Probe B (GPB) –Scheduled from VAFB Sept 24– This is currently under review. It is good science, but budget overruns have been $163 million since 1999. This has never gone through a competitive review, but it will have one soon. The review committee is to address whether the science coming from this project is worth the science that is not being done because it is taking money from, and therefore delaying, other projects. If the review committee approves continuing, the money may have to come from LISA.
- CINDI–Scheduled from KWAJ Nov 30
- SWIFT–Scheduled from CCAFS Dec 5.

Education and Public Outreach

Dr. Weiler announced that OSS published a Braille book on HST astronomy. It was very well received. Braille books are very expensive because outdated technology is used to produce them. As a result of this experience, we decided to work this coming year, with a blind astronomer, on how to update the technology used to produce Braille books. We want to make them faster and cheaper.

In addition, OSS helped create a Space Science Bachelor's Degree Program at CUNY. In FY 2002, there were 330 Education and Public Outreach (E/PO) activities and 70 new products. We had a presence at 22 national and 30 regional E/PO conferences and had a presence in all 50 states, as well as in DC and Puerto

Rico. Finally, we received more than 30 awards and other forms of public recognition for our E/PO programs and activities.

2002 Science News Metrics– Contributions to World Discoveries and Technological Achievements
By the end of this year, NASA published 50 of the best top science stories of the year. NASA posted and/or received 7.2 percent of the world's science news. Space Science was 76 percent of that science news coverage.

NASA has fully funded only one Noble Laureate Prize in Science winner, Dr. Riccardo Giacconi, an astronomer who was funded by OSS. After receiving the Nobel Prize, he was also honored by NASA.

Recommendations from August 2002
Dr. Weiler concluded his presentation with a status report on each of SScAC's recommendations from the August 2002 meeting.

1. Formally engage all organizations that utilize measured solar wind variables to identify the responsible agency and methodology by which monitoring of the interplanetary environment at L1 will be accomplished and maintained. *Dick Fisher will address during SEC presentation.*

2. Concern about status and future of launch capabilities for smaller spacecraft and payloads. Would like background information and support as SScAC develops position. *Karen Poniatowski will address during launch services outlook presentation.*

3. Concern that budgetary pressures may negatively impact FY03 funding for the NSI. *Budget for NSI is strong in FY03 budget; nuclear propulsion significantly more robust with proposed Project Prometheus in FY04 request.*

4. SScAC requests integrated response from OSS and OAT on technology roadmaps. Technology requirements flowing from the Enterprise Strategy should be reviewed in light of the OAT and OSS funding plans.
OSS and OAT are working closely; however, with the much-delayed passing of an FY03 appropriation, our efforts have been hampered. Fully updated discussion will be provided in the summer meeting.

Discussion
In response to a question about how the Columbia accident will affect OSS missions, Dr. Weiler informed the Committee that OSS does not have a payload for the shuttle, so there will be no impact, except for a HST servicing mission scheduled for a 2004 shuttle launch. It is possible that this may be delayed; it is too early to tell. However, Discovery launched HST, and Endeavor fixed it. So any shuttle can service and return the spacecraft. Only the air lock would need to be reconfigured.

The safest way for HST to reenter is with the shuttle. OSS will calculate the full cost of returning Hubble and will tell Congress. NASA will keep the Hubble data archive going; there is a lot of good information there. If we service it in 2007, HST's life will have been extended by 30 to 70 percent. Only NASA is supporting the HST financially and it is costing too much to continue.

In response to another question, Dr. Weiler explained that earmarked projects are those projects or programs for which the money is not competed. The recipients are designated by Congress.
Dr. Weiler then reviewed a list of earmarked projects.

Committee members queried Dr. Weiler about major content and budget changes from the FY 2003 to the FY 2004 President's budget, and he reviewed them. In FY 2003, the Space Science Enterprise received $3,906.9 billion. In FY 2004, $ 4,007.1 billion was requested. However, a major change is that this is a full cost budget and includes all launches and Goddard personnel. The increase is +100.2 million.

Dr. Weiler concluded with the information that OSS inherited DSN, and we will try to fix it. The average number of launches annually is about 5, but this year is busier. More launches are the result of "faster, better, cheaper."

Dr. Andrew Christensen expressed the Committee's appreciation for Dr. Weiler's openness and the thoroughness of his presentation. He congratulated Dr. Weiler on the new initiatives.

Astronomy and Physics (A&P) Division Report

Dr. Anne Kinney, A&P Division Director, began her report with a review of FY03 through FY08 budget allocations and launches for LISA (2011 launch) and Constellation-X (Con-X) (2013/14 launch). The review will assess the feasibility of the plans for completing mission formulation and mission implementation, including the overall mission cost, schedule, and the realism of the proposed launch dates. Although we want to launch LISA first, whichever is further along will be launched first.

Dr. Kinney quickly reviewed the Space Infrared Telescope Facility (SIRTF) launch schedule and importance. A detailed presentation on SIRTF will follow her presentation.

Continuing, Dr. Kinney expanded on the previous discussion of the HST. They want to move forward the planned 11/04 servicing to put two more science instruments on telescope. Dr. Kinney shared that there will be a fact-finding review on propulsion models to see how to retrieve the observatory in 2010. She would like to bring Hubble down when it no longer functions. If HST fails before 2010, its R & A funds will go to analyzing archive data. She will put together a review committee on how to use the R & A funds.

Dr. Kinney reported that the Beyond Einstein program would be structured the same way as the Origins program. She appointed some of the top people already, had a press conference, and another one is planned. Thus far, it has received good press.

The Einstein Probes NRA will solicit mission concepts for the Probes. Three concepts per probe will be selected. However, it was noted that the Einstein Probes would not be funded until 2007, and then only at an introductory level, i.e., at $1 million per year for up to 2 years. There are two concepts for the Dark Energy Probe–a complete mission or a contribution to DOE's SNAP. It was noted that DOE operates differently from NASA. NASA wants to compete the Dark Energy Probe.

The presentation continued with a report on an OSTP-led interagency working group on Physics of the Universe for which Dr. Kinney is a co-chair. The first formal meeting was February 25. They are to present a set of recommendations in response to the NRC Turner Report, "Quarks to Cosmos." The group will also address issues that cross agencies and hamper collaboration. They hope to have the report finished quickly, hopefully within 6 weeks.

Dr. Kinney told the Committee that she would prefer the Origins and SEU subcommittees made into Federal Advisory Committee Act (FACA) committees, so there can be direct communication to her from the science community.

The presentation shifted to a report on Gravity Probe-B's (GP-B) history of schedule delays, cancellations, reinstatements, and cost growth. In the last 39 months, there have been five replans and 37 months of delay. The spacecraft budget has increased by $163 million. The total cost is now estimated to be $516 million. Dr. Kinney said that she was losing confidence in it being successful. Two review committees are being established. One committee will assess if there is a path to launch that is doable. The second committee is to determine whether if GP-B were cancelled permanently the loss of data would be irreparable.

Dr. Kinney then moved on to discuss the James Webb Space Telescope (JWST) program. JWST will receive the HST funds after it ends. The original budget estimate was $500 million. At present, it is estimated that

JWST will cost $1.9 billion to complete, and this does not include the European share. They are waiting for the Langley budget office's cost estimate. Cost of the project is a serious problem, but JWST is a highly favored program in the astronomy community.

Dr. Kinney reported that she had brought on a new JWST project manager in whom she has enormous confidence. He will examine the program organization at Goddard to see if the project could be reorganized to save money.

It was explained that the original $500 million budget was when JWST was to be a 4-meter telescope. Mr. Goldin turned it into an 8-meter telescope, which is considerably more expensive. Dr. Das expressed that the SScAC should have a process to deal with situations like this, i.e., projects that are redefined after SScAC approval. This committee approved the program when it was projected to cost $500 million; it may not have been approved if it was known that it would cost $1.9 billion.

The Committee was informed that the Space Interferometry Mission was saved by changing its Level 1 science requirements. After changing the priorities, OSS had the science community review the replan to see if the new priorities were worth funding. They said it was.

The same scenario could happen with JWST if there were an acceptable replan result. Dr. Kinney relayed the ground rules for the replan to the SScAC. The replan must provide high confidence in meeting requirements, cost, and launch date. Dr. Kinney noted that slipping the launch dates a year or two will not help, because money is needed to develop instruments. Those are generally completed 2 years before launch. So adding money to the end will not solve the problem of not having enough money to develop the needed instruments. We do not have the money in the right years. At present, she does not have a solution.

Moving on, Dr. Kinney quickly reviewed the status of all the Structure and Evolution of the Universe missions, the Astronomical Search for Origins missions, and the Astronomy and Physics operating missions. Dr. Kinney expressed pride in the Keck Observatory sharing data with the scientific community. She reported that data from all observers would be archived.

She reported that the Technology Plan for TPF was updated and is on track. The Science Roadmap is being developed. The Technology Plan is to be released soon. And the TPF science amendment to the ROSS-03 NRA is to be released in early March.

Community support activities included sponsorship of 2003 Michelson Science Center (MSC) Fellowship Program and MSC summer school. The MSC's mission is to facilitate the timely and successful execution of NASA's Origins science investigations within the Navigator Program. The Navigator Program Education Internet site was redesigned. It is bolder, innovative, and includes an interactive 3-D model of SIM. It received favorable coverage in *New Scientist* and *Natural History.*

Dr. Kinney reported on the Antarctic Long Duration Balloon (LDB) flights. She informed the Committee that BOOMERANG is the last balloon program that will be supported by NSF. NSF reprioritized their Antarctic program and put balloons on the bottom of their priorities and, consequently, is dropping them. NSF said that this was in response to the astronomy and astrophysics NRC decadal survey. Dr. Kinney expressed NASA's deep concern about this situation. NASA does not have the money to pay for the replacement of the infrastructure needed to support Antarctic flights. In addition, the Antarctic is essentially owned and operated by NSF. Ballooning is important, particularly for students. OSTP ruled that NASA should be responsible for building the facilities, while NSF should be responsible for maintaining them.

Dr. Kinney concluded her presentation by telling the Committee that the MOU that would facilitate flying balloons over Russian territory has not been signed. Consequently, two payloads planned for launch in June 2003 were postponed. They are trying to get an agreement by August 2003 for FY 2004 flights.

Space Infrared Telescope Facility (SIRTF): Six Weeks to Launch

During lunch, Dr. Michael Werner, Project Scientist, JPL/Caltech, gave a presentation to the SScAC on the status and elements of the SIRTF. He began by informing the SScAC that SIRTF was on a truck on its way to Cape Canaveral, Florida. While SIRTF is small in comparison to JWST, it has many innovations. The SIRTF Observation is a multi-purpose observatory cooled with liquid helium for astronomical observations in the infrared. It will be launched April 15, 2003, for a 2.5 to 5 year mission in orbit around the Sun, not the Earth. It will provide a 100-fold increase in infrared capabilities. SIRTF completes NASA's great observatories, and it is the first major space mission in NASA's Origins Program.

Why use infrared in space? Infrared can look through dust. Some things can only be seen by infrared light; diffuse clouds of interstellar dust and gas are opaque to visible light. Almost half of the energy emitted in the Universe after the Big Bang is infrared. SIRTF will search for its origins. Most of the light that comes from distant galaxies is in the infrared. Earth's atmosphere is warm and emits copious amounts of infrared radiation that greatly limit the ability to measure faint objects from the ground. The infrared array observations will revolutionize the clarity of the images seen in space. Its images are very significantly sharper. Models suggest that SIRTF can resolve between 20 to 60 percent of the infrared background into the point sources that produce it. That, in combination with its sensitivity, makes this a very powerful instrument.

The deepest images taken by the HST, Chandra X-Ray Observatory, and SIRTF will be in the same patch of sky. Together, these coordinated images will show what galaxies looked like when the Universe was less than 10 percent its current age. These panchromatic images will help us begin to understand when and how galaxies form. With infrared, we can distinguish which galaxies are old and which are young; ultraviolet light cannot distinguish this.

Dust particles that form planets glow brightest at the infrared wavelengths where SIRTF will be observing. Comets in our own solar system also give off dust particles. SIRTF will show how the composition of our solar system relates to that of other planetary systems.

The observation time will be allocated in three categories. The entire scientific community will receive 75 percent of the observation time. Most of that time will go to the Legacy Science Program, composed of large coherent investigations of lasting importance. Six have already been chosen. The remaining portion will go to other science programs that will compete through proposals for observation time. All of these data will be placed in the public archive immediately. The Science Working Group (SWG) members and instrument teams receive 20 percent of the observation time for the first 2.5 years; 15 percent thereafter. The SIRTF Director will receive 5 percent discretionary observation time.

Dr. Werner informed the Committee that the SIRTF Project broke a lot of paradigms. The SIRTF telescope will be launched warm and cooled down in orbit. This novel approach yielded significant cost and weight savings over cold launch designs with no reduction in telescope size for a given desired lifetime. Future NASA missions, e.g., TPF and JWST, will use this same approach. Dr. Werner concluded his presentation with an operations schedule and with a forecast of the scientific promise of SIRTF.

The SScAC was extremely pleased with the presentation and the program. A comment from a member pointed out that regardless of how big you make a telescope on the ground, it still won't be able to detect what SIRTF will be able to see in the infrared. In response to a question aboutwhat a 6-meter telescope would be able to do in space, Dr. Werner explained that a higher resolution spectrograph would be feasible. JWST will extend the results of what SIRTF can find.

Launch Services Outlook (Videoconference)

Karen Poniatowski, Assistant Associate Administrator for Launch Services, Office of Space Flight (OSF), made a presentation via video teleconference. Ms. Poniatowski informed the members that the Launch Services Program is responsible for identifying and aggregating Agency launch requirements and finding a way to meet

these requirements and manage priorities and conflicts. Launch Services management approach is to provide a single interface at Headquarters for Enterprise payload customers and to identify and resolve, through the NASA Flight Planning Board, space access issues and manifest conflicts. The KSC ELV and Shuttle Payload Carrier programs were consolidated into the Launch Services Office. OSF has a diverse customer base seeking space access. The challenge is balancing the requirements of the diverse customer base with constrained resources and stagnant external market conditions.

The current domestic commercial market trend is to larger spacecraft and vehicles. However, NASA is looking at smaller payloads. Most USAF launches are migrating to Enhanced Evolved Launch Vehicles (EELV), which are for large payloads. AtlasV/Delta IV account for 79 percent of demand. Delta II is approximately 13 percent of DoD projected demand. Their Space Test Program has minimal small class dedicated launch requirements.

Launch Services recently did a 10-year launch forecast analysis–2003 to 2012. Only 20 (15 %) of the 134 launches were for small payloads. There has been a stagnant market since 2000 that is predicted to continue in the future. The international market has gone flat. There is an oversupply of international services in the larger vehicle classes. U.S. industry is again dependent on the U.S. government requirements for a stable base. In addition, their investment capital for emerging services is drying up. NASA launch management has been consolidated at Kennedy Space Center.

NASA has firm fixed price launch service contracts in place to meet Agency launch requirements in all performance classes for missions planned through 2009-2010. We are using competitive launch service task orders (LSTO) for a block buy of up to 19 Delta II's to maintain a steady state manufacturing base. Aggregating requirements enables block buys of launch services and continued space access in performance classes with flat demand. The impacts of a stagnant commercial market on NASA missions have been a key issue for the past year.

Currently, NASA has the capability to meet all identified mid and near term needs. However, space access is at a crossroads. Domestic launch service providers are having difficulty maintaining a business base. The viability of domestic small and medium ELV capability beyond 2010 continues to be a challenge. Over 80 percent of NASA ELV missions are in the Pegasus (small)/Delta (medium) performance class. NASA demand alone is insufficient to sustain a robust, competitive industry. NASA dominates Pegasus demand, with an occasional USAF mission. Beyond 2006, NASA is the only identified user of Delta II.

NASA has three contracts to acquire Delta II launch services, which continues that capability through at least 2009 at Vandenberg Air Force Base (VAFB) and CCAS. This enables continued production line capability and critical skills retention. However, long-range missions are not addressed in the current contracts because they are not sufficiently developed to know what will be needed.

Subsequent to 2009, there will be significantly higher performance and launch costs for the medium performance class. Our options are to:

- Solicit industry solutions to Delta II class requirements
- Release another Delta II block buy to support launches through 2015
- Begin design of all payloads for dual compatibility with both EELV's, or
- Develop dual payload adapters for both EELV systems.

OSF will keep Enterprise customers apprised of progress for meeting long-range launch requirements. If the government decides not to continue to support Deltas, then the payloads would either have to reduce in size or increase. This has to be worked out over the next 9 months.

The same issues exist for the small performance class. OSF needs to deal with how to keep Pegasus production alive when only NASA has small missions that will need Pegasus class capability. We project that there will be insufficient demand to support a stable business base for even a single provider. OSP is looking

to aggregate demand for missions seeking launch through 2009 and issue a contract by September 2003. Long-term small class requirements will be assessed in 2005. The USAF FY 2004 budget request includes assured access funding for EELV's. In addition, the USAF is assessing the costs/benefits and action required by DoD to support the viability of two domestic suppliers vs. reliance on a single provider.

We may have to make our payloads secondary EELV payloads. However, secondary flight opportunities are often not identified until 2 to 3 years before a specific launch. NASA has formally requested OSTP support for NASA acquisition of international secondary payload launch services for the OSS Space Technology 5 missions.

Ms. Poniatowski then reviewed NASA's EELV requirements and status, the new vehicle certification program, the use, evolution, and pre-Columbia budget manifest of the Shuttle. She concluded her presentation with Shuttle use priorities and pre- and post-Columbia Shuttle considerations.

Discussion

In response to a question about National Space Transportation Policy, Ms. Poniatowski responded that NASA did help rewrite a new space transportation policy, which the President was going to sign. However, it was deferred until the Columbia investigation is completed.

Dr. McComas proffered that SEC is interested in the smaller payload launch capability and the Delta is too big. SEC wants to help retain that type of launch capability and asked for Ms. Poniatowski's suggestions on what to do. Ms. Poniatowski suggested that the committees educate the political system about the need for a steady state production line to continue producing small vehicles. There have to be a minimum number of vehicles produced annually for private industry to continue production. The Air Force is not a customer for these smaller vehicles, as they have migrated to the heavy end vehicles. The government demand is not adequate to sustain this market, not even for one company, which currently is Orbital.

Lockheed is not in this market. Boeing is still producing Delta II. They are trying to continue producing them by consolidating production. Orbital is the only one producing the smaller Pegasus. They need to produce three a year to keep them viable. The company is training their staff to work on more than one type of vehicle.

The Chair expressed his concern that small payloads won't be able to be launched any longer, a backward step for science. Ms. Poniatowski explained that 5 years ago no one could have seen this bust in the market. With the small vehicles, she can only project a 5-year horizon with any assurance. With Delta, she can do a 7-year horizon; with larger vehicles, a 10-year horizon can be projected.

A final comment was that Pegasus' continuation is highly doubtful. This is a big problem.

Solar System Exploration Subcommittee (SSES) Report

Dr. Jonathan Lunine, University of Arizona, the new Chair of the Subcommittee, began by telling the SScAC about his background, education, experience, and interests. Dr. Lunine said that he is looking forward to working with Orlando Figueroa and Colleen Hartman. He reported that 6 or 7 members are cycling off the Subcommittee and need to be replaced, which means a lot of change.

He continued with a short report of what will be discussed at the SSES meeting that will take place March 6-7, including the continued development of SSE's roadmap. He did a reprise of the budget presentation and gave a short status report on Solar System and Mars exploration and the Prometheus program. These are discussed in detail in subsequent presentations.

Dr. Lunine then gave a comprehensive presentation on astrobiology, which is the study of the origin, evolution, distribution, and future of life in the Universe. Astrobiology provides an intellectual foundation to prepare for and guide future space exploration opportunities. Astrobiology research will make it possible to recognize habitable planets beyond our Solar System and to explore the biological relevance of planets within our Solar

System–especially Mars and satellites of the outer planets. He relayed the astrobiology community's plans for the next decade, which are to:

- Understand the nature and distribution of habitable environments in the Universe.
- Explore for past or present habitable environments, prebiotic chemistry, and signs of life elsewhere in our Solar System.
- Understand how life emerges from cosmic and planetary precursors.
- Understand how past life on Earth interacted with its changing planetary and Solar System environment.
- Understand the evolutionary mechanisms and environmental limits of life.
- Understand the principles that will shape the future of life, both on Earth and beyond.

The field is very fundamental and should be integrated into all OSS roadmaps. He and the Subcommittee are happy to advise the SScAC in prioritizing future research opportunities and plans to help develop the appropriate roadmaps.

Dr. Lunine supported making the SSES a FACA committee.

Structure and Evolution of the Universe (SEUS) Subcommittee Report

Dr. Edward "Rocky" Kolb, Fermi National Accelerator Laboratory, Chair of the SEUS, met the previous week with the SEUS and relayed highlights of the meeting. Dr. Kolb showed the SScAC the significant increase in image resolution this past month of the Wilkinson Microwave Anisotropy Probe (WMAP). This was accomplished by merging five channel bands. He shared the new results obtained by WMAP. The scientific community is thrilled with the results of the probe.

Dr. Kolb explained that the Beyond Einstein Program consists of three inter-linked elements:

- Einstein Great Observatories – LISA and Con-X
- Einstein Probes – to address focused science objectives including:
  - Determine the nature of the dark energy
  - Search for the signature of inflation in the microwave background
  - Take a census of black holes in the local Universe
- A technology program, theoretical studies, and an education program to inspire future generations,

This program, except the Probes, is in the President's FY 2004 budget. The Probes will be funded starting in FY 2007. Dr. Kolb reviewed the next steps, the Probes NRA, the NRC Physics of the Universe report, Antarctic Long Duration Balloon (LDB) flights, and the Antarctic and Arctic ballooning situation, all of which were discussed in detail in Dr. Kinney's presentation. He reported that the SEUS supports the plan to have two panels review the Gravity Probe B project, along with the budget review, prior to a decision about whether to continue funding the project.

Dr. Kolb also described the Ultra Long Duration Balloon (ULDB) Program. These balloons are sealed and fly for 100 days at an altitude of 30 km. They have the capability of carrying a 1000 kg science package. Questions are, can they replace some SMEX-class missions and can they be used for technology validation? He continued with a description of issues of concern. They include the technical risk of flying over inhabited areas and the requirement to obtain foreign governments' permission for overflights. The other concerns are: ULDBs cost a lot more, but it is a new technology; who should pay for them? Should NASA help? Is NSF going to discontinue funding for operations?

Dr. Kolb concluded his presentation with a short discussion of Radioastron, a program with Russia which has been discussed since the 1980's. We have an international agreement signed in 1997. It was supposed to fly in 2000. The Russians now say that launch will be in 2006. SEUS heard presentations on the science value and the probability of the project being completed. As a result of the discussions, SEUS is recommending that this program not be funded by NASA any longer.

Project Prometheus, the Nuclear Program

Mr. Alan Newhouse, Program Director of Project Prometheus, began his presentation by telling the Committee about his extensive nuclear power experience. He worked for Adm. Rickover on developing the nuclear reactor submarine and with DOE on the space reactor program.

The presentation compared today's space propulsion and power (i.e., chemical propulsion and radioisotope power) capability with future capabilities using nuclear electric propulsion. With nuclear electric propulsion, there is much greater ability to change speed, practically unlimited power for instruments, vastly greater ability to transmit science data to Earth, no need to use gravity assists (which eliminates launch constraints), significantly greater observation time, as well as the ability to change targets mid-mission. There is also precise navigation and the ability to change orbit. Because of these capabilities, the use of nuclear power and propulsion will enable a new strategic approach to Solar System exploration and is likely to play a key role in NASA's future. Mr. Newhouse assured the SScAC that safety is their highest priority.

He continued with the key components of Project Prometheus:

- Radioisotope power systems development
- Nuclear propulsion research
- JIMO development

Mr. Newhouse expanded in detail on each of these components. The use of radioisotope power systems will increase capacity to conduct long-lived deep space and planetary surface exploration. The safe use of nuclear electric propulsion (NEP) technologies will revolutionize the way we operate and design missions, but technical challenges need to addressed, e.g., automated operation, high reliability and extended life capabilities, design for start-up and re-start, power requirements, and recovery options. Continuing, Mr. Newhouse reviewed the specific impulse, power, efficiency, and maturity of various electric propulsion technologies, as well as explaining nuclear reactor heat-to-electrical power conversion technologies and their capabilities.

He then gave examples of space science candidate missions enabled by NEP, including JIMO, Titan Orbiter and Surface/Atmosphere Explorer, Neptune System Orbiter, and Kuiper Belt Object Reconnaissance. There would also be the capability to use surface nuclear power, e.g, lunar and Mars surface power to conduct science, human exploration, and deep subsurface drilling. Mr. Newhouse went on to suggest that it could also be used for Earth protection by having near-Earth object (NEO) reconnaissance and characterization and potential mitigation.

The presentation continued with a dramatic comparison of current power, data return, and time on-station available with nuclear power. The amount of power available to science instruments currently is the equivalent of one bedside reading lamp; with NEP, equivalent to a stadium light. The amount of science data return currently is 1 to 2 floppy disks as compared to 120 CD-ROMs. The time available for science observation of Jupiter's moons is 1 to 5 hours as compared to 180 days. It was equally dramatic when Mr. Newhouse visually compared the power capability of the Voyager, Galileo, and Cassini with the JIMO, e.g., on-board power generation 480, 570, 875 watts respectively, as compared to 100,000 watts on JIMO.

Organizational principles were reviewed. The Committee was informed that an NRA will be issued on how all this might be accomplished.

Mr. Newhouse reviewed organizational accomplishments as of February 2003. A program plan has been developed. A streamlined and focused organization was established. It now incorporates an external affairs officer to engage the public, an advanced concepts officer to address future missions, and a JIMO program scientist. JPL was assigned responsibility for the JIMO Project, and they are ready to begin work. The Project Prometheus Program (PPP) will retain the original organization of responsibilities among NASA Centers and DOE to implement the portions of the program (radioisotope power system development and nuclear propulsion research).

The organization charts for NASA Headquarters Project Prometheus, JIMO, and inter-Agency, inter-Center organization were presented. Mr. Newhouse then reviewed all the power conversion and high power electric propulsion projects moving to Prometheus in FY 2003. His presentation concluded with a discussion of the technologies that will be developed for JIMO that can be extended to a broad range of future space exploration missions, e.g., power conversion and fabrication capacity, and to terrestrial non-nuclear and nuclear uses, e.g., proof of modern reactor components, design capabilities, and safety. He predicted that the Nuclear Systems Program would have applications beyond NASA and space exploration, e.g., high temperature nuclear fuel for future high-temperature gas-cooled nuclear plants.

Discussion

In response to a question concerning development timing, Mr. Newhouse explained that they would do the definition of the science in parallel with the development of reactor technology that meets the stated requirements. HST did not develop its technology until much further along in the development of the science. Consequently, HST took much longer to develop and much more money than anticipated. JIMO will be different. We are going to develop science and technology simultaneously, partially because we will not know what we can do definitively until we know what technology will be needed, if it can be developed, and how much it will cost. OMB put this program into Code S so technology would not be developed in isolation and then turn out not to be useable. We will not pay to have instruments developed until we know for certain that a nuclear reactor that will meet the requirements can be built and run. If this technology does not pan out, then we do not need to develop the instruments.

Eventually, there will be a science advisory committee for this program. We will also have a nuclear subcommittee that will report to this committee, but it will not be a FACA committee. Mr. Newhouse assured the SScAC that a group of scientists and engineers reviewed the concept for this project. Also, Mr. Newhouse said that he and others on the team have worked very closely and successfully with DOE and feel that we can work successfully with them.

Members said that it would be exciting to get infrared telescopes on station using the reactor. Dr. Illingworth expressed concern that while this is exciting technology, we may lose other science projects to it. He asked if the planetary people said they support this. Dr. Weiler responded that the science community views money very differently from the OMB and Congress. If the science community does not support this project, the political reality is that this money would not be available for any other projects. Consequently, there is no point in asking the community to assess whether this money would be better used on something else, because it wouldn't be available for anything else.

Dr. Hammel, who was on the NRC Survey Committee, said she supports this program. She thinks it is a good way to implement the decadal recommendations made by the Committee.

It was noted that we have learned that we had to pair development of technology with a science mission. Plus, Congress supports nuclear propulsion. There was general consensus that chemical propulsion will not get NASA anywhere we haven't already been. It is simple physics. Furthermore, this will give wonderful opportunities to young nuclear engineers. Congress also liked this education aspect.

Solar System Exploration (SSE) Division Overview

Dr. Colleen Hartman, SSE Division Director, began by reviewing the SSE Division budget changes in the President's FY 2004 budget request. The SSE Division received a 34 percent increase, although there was a decrease in the Nuclear Electric Propulsion and Nuclear Power Programs.

The New Frontiers program starts off slowly in FY 2003, but increases from $15 million to $130 million in FY 2004 to $210 million in FY 2005 when it achieves a steady state. New Horizons/Pluto Kuiper Belt (PKB) will be the first New Frontiers mission. A New Frontiers Announcement of Opportunity (AO) is due out this summer for a second mission. There has been a new start for the New Frontiers Program in FY

2003; it is now structured along the lines of the highly successful Discovery program but with a significant difference. The highly ranked missions from the NRC decadal survey will prioritize the program. New Frontiers provides frequent, affordable mid-sized missions that perform high-quality planetary science investigations with missions selected through a competitive process. Each mission must launch within 47 months from start of development.

Dr. Hartman continued with a description of the main programs constituting the Nuclear Systems Initiative (NSI), which is now called the Project Prometheus Program. These details and highlights were conveyed earlier in Dr. Weiler and Mr. Newhouse's presentations. However, it is important to note that Prometheus is science driven, and scientific advice will come to the Division Director from the Nuclear Concept Definition Team (NCDT). Their central question will be: What kinds of missions and scientific research in deep space would be enabled by 100 to 250+ kilowatts electric power availability. The Jupiter Icy Moons Orbiter (JIMO) is the first mission within Prometheus. Science for JIMO and all follow-on PPP missions will be managed out of the SSE Division. A NRA for development of high power instruments for planetary exploration is scheduled for release later this month. We are planning a workshop, possibly in June, for the larger scientific community to discuss JIMO and long-term strategies.

The JIMO will be nuclear electric propulsion-powered, which will allow full characterization of all three icy moons. There is evidence that liquid water has played an important role in the evolution of all three icy moons. Comparative orbital reconnaissance of these potential oceanic environments is a key to understanding the biological potential of the solar system.

Dr. Hartman then reviewed the operating mission status for all the Solar System exploration missions. Stardust continues on cruise, with monitoring of dust ended, aerogel collector stowed, and sample return capsule closed. Genesis's solar wind sample collection continues. In-flight battery temperatures continue to trend above model predictions; however, it has leveled off, at least temporarily, as the spacecraft passes perihelion. The ground battery test program is still yielding good margins. Follow-up thermal peer-review is planned for April 2003. The Deep Impact project deemed its January 2004 launch not viable. A replan plus cost impact for a 1-year delay in launch were presented at a termination review in February 2003. Messenger's schedule is tight. The structure and integrated propulsion subsystem has been delivered. The Contour mishap investigation board is working on their preliminary report which should be complete within the next two months. Netlander's mission confirmation will not be given a 'go' due to loss of the CNES flight opportunity. The ASPERA-3 project delivered all products to the program. It may need to complete software post-launch due to delays of foreign partners. Dawn: an instrument descope (laser altimeter) is under consideration to increase reserves. GSFC has increased their cost estimate for instruments, which will further reduce reserves. Kepler's detector chips are being delivered on schedule, and the evaluation of the optics contract is underway. The ASIC procurement issue is resolved. Cassini's science operations plan implementation is on schedule and doing quite well. OSS gave them more money because they were getting a little behind. The Galileo spacecraft is operating normally. The DSN's network simplification plan is back on schedule. Preparations for 2003/04 activities are proceeding well. Discovery received a "green" from OMB, but Dr. Hartman thinks that it is overly ambitious and that it needs to be paired with technology. The program keeps exceeding its funding cap. SSE will raise the cap, but will require minimum reserves of 25-30 percent, so it may have to reduce the science. This program will have much stronger HQ oversight. We are hiring a senior person who will be in charge of all Discovery and New Frontiers projects. We will also put HQ oversight staff at JPL.

Dr. Hartman continued with a quick review of in-space propulsion significant accomplishments. In conclusion, Dr. Hartman named the positions SSE is looking to fill and announced new hires.

Mars Exploration Program Report

Mr. Orlando Figueroa, Director, Mars Exploration Program Office, began his presentation by reporting on the development and budget status of approved missions. The FY 2003 and FY 2004 President's budgets fully funded NASA missions in operation, and in formulation or implementation through 2009 (MGS,

Odyssey, MER, MRO, Scouts, MSL). The FY 2003 President's budget included funding for support and participation in international collaborations (ESA/Mars Express, ASI/SHARAD for MRO, 2007 G. Marconi, 2007 CNES Premier, 2009 ASI/NASA Orbiter). The FY 2004 budget includes funds for the above collaborations except for 2007 G. Marconi and 2009 ASI/NASA Orbiter. ASI cancelled funds for G. Marconi and the Orbiter. NASA budgets for those projects were put into a 2009 NASA Mars Telesat. Both FY 2003 and 2004 include robust R&A and Technology Programs. However, the FY 2003 budget removed funding for missions beyond 2009. The President asked that more options than just Mars Sample Return be developed for funding in FY 2009. FY 2004 President's budget includes development of a multi-mission radioisotope thermal generator (MMRTG) for 2009 MSL.

The G. Marconi international science collaboration project highlights the importance of the U.S. not making a foreign country's contribution critical to the success of a program. On a happier note, both the ESA/Mars Express and ASI/SHARAD for MRO projects are doing well. The former will be shipped for launch on ESA's spacecraft in the weeks following the SScAC meeting.

Issues for consideration with the 2005 budget include assessing the science to see if it is worth extending missions in operation (MGS and Odyssey). Also, until funds are restored for the next decade of Mars exploration, nothing new can be started. CNES has severely de-scoped Netlanders; it is delayed to no earlier than 2009. At present, the Netlanders lack launch, cruise and telecomm capability, and have no way to get to Mars. OSS now must figure out how to recover the science. Canada is committed to Scout collaboration (if selected), but their request for augmentation to collaborate on MSL and beyond was not approved.

Mr. Figueroa continued his presentation with a review of the status of missions in operation and in formulation or implementation through 2009. Mars Global Surveyor is proceeding well; there will be a decommissioning review FY fall 2003. The Odyssey has been a great success thus far. The Mars Reconnaissance Orbiter mission is proceeding well. It contains nine science instruments and will collect more data than most other missions have. The mission operations/data system PDR was successfully completed. Launch is scheduled for October 2005.

Four competitively selected Scout Mission Phase A projects will be down-selected to one mission in August 2003 to move forward to completion. There is $325 million budgeted for this project. The reserves are from 20-30 percent. The Mars Science Laboratory mission is to start Phase A in June, with a concept review August 2003. It will have three types of instruments onboard: contact, remote, and analytical. It already is having trouble staying within budget. The preliminary experiment plan for an optical demo of the 2009 *Mars Telecom Orbiter* is due the end of March 2003. This mission's total cost is estimated to be $500 million.

The Mars Exploration Rovers A and B (MER) pre-shipment reviews were successful. The rovers were all assembled and tested prior to shipping to Kennedy Space Center (KSC), except the parachutes. Parachute design qualification is at ARC where they are being built, and then they will be delivered to KSC. All the parts will be assembled at Kennedy. However, there is a tight schedule till launch with a lot of work remaining to be done. The surface operations and science software have not been completed. This requires increased work so modules will be available to address all possible scenarios that might be encountered. Other areas of concern are the APXS alpha particle detectors and closure of anomaly reports.

The rovers use solar power, so they must land on the lighted side of Mars. Rover A launch date is May 30, 2003; it lands January 4, 2004. Rover B launch date is June 25, 2003; it lands January 25, 2004. Any of the landing sites are viable for these two launch dates. Landing sites will be chosen April 10. We have 16 days of margin on the launch date for Rover A and 46 days for Rover B. There is concern about how much is left to do at Kennedy. If we miss the date for Rover A, we would have to wait till November 2004 to launch again. However, these 2003 dates provide much better conditions.

In response to a question on how to deal with development work going on after shipment to the space center or launch, the Committee recommended separating the development team from the operations team. Mr. Figueroa was queried about samples brought back from Mars. He explained that a special facility would have to be built to isolate and hold the samples, and NASA does not have the money to build such a facility. He did think that after the astrobiology field laboratory is built, samples could be brought back. The science community is divided on sample return or doing *in situ* testing, but does not want to give up on getting samples.

The presentation concluded with the Mars Exploration Program's launch schedule from 2001 through 2009. The SScAC commented that the schedule looked very aggressive. They wanted to know what the impact of rover failures would be on subsequent activities. The response was that the program might not continue.

Tuesday, March 4

General Committee Discussion

Because the meeting was ahead of schedule, Dr. Christensen began the Committee's discussion on topics identified for Committee comment. The discussion continued and was finalized following the remaining presentations. A summary of both discussion periods is provided in one place following the summarization of all the presentations.

Origins Subcommittee (OS) Report

Dr. Alan Dressler, Carnegie Observatories, Carnegie Institution of Washington, Chair of the OS, reported on the issues and progress of the projects within their area. He began with this statement: The quest for the exotic and the quest for our origins is a good way to divide astronomy programs for the public. The quest of the exotic excites the public. The quest for our origins, and perhaps our destiny, can come from the stars. This is a worthy goal.

OS issues include the NASA Astrobiology Institute (NAI). The NRC Committee on the Origin and Evolution of Life (COEL) and the OS expressed concern that NAI has insufficient content in the astronomical research component. They suggest a parallel virtual institute concentrating on the "astro" in astrobiology. At the February 2003 meeting, OS heard a very impressive presentation of the new Astrobiology Roadmap. They also heard the present NAI science scope from Rosalind Grymes. It became apparent that the principal goal of NAI is to create the field of astrobiology as a recognized discipline supported by University faculty appointments. These actions are to create a new science, which makes this more than a grants program. Dr. Dressler then informed the SScAC that there are 400 associated scientists—who already make up a virtual institute. A building would not make this current fluidity possible. The OS consequently concluded that thoughts about a new astronomical origins institute are premature. Further evaluation of NAI would be helpful, as would regular reports to OS from NAI. The OS will watch the results of the present competition to see if astronomical research continues to grow at NAI.

In regard to progress with SOFIA, a 2.5 meter infrared telescope to be flown on a Boeing 747, the telescope has been integrated into the vehicle. The first flights are scheduled for 2004. They are a few months behind schedule and tight in the budget (some reserves are committed). There has been good progress on the data cycle (pipelines, archiving, etc.), an area of previous concern to the OS. OS is concerned that there will be separate time allocation processes for the US and Germany, because a joint process would be better. However, Germany is not interested. Our second concern is that the German instruments are P.I. instruments, and there are no provisions for data pipelines or archiving as there is for facility instruments. The SOFIA project is working on both issues.

The OS supports the two committees proposed by Dr. Kinney to decide the future of HST. We have been assured that both committees will have considerable latitude within certain basic realities, e.g., the trade off between extending the HST mission for JWST implementation schedule, etc.

The OS received a review of the work on the Terrestrial Planet Finder (TPF) mission at JPL. Dr. Beichman reported that a well-coordinated program has emerged that is pursuing two leading technologies–a visible light coronograph and/or a mid-infrared interferometer. He believes that the technology issues will themselves settle the choice of technique that will be used. They are making good progress on the coronagraph, as they are on infrared nulling. Dr. Beichman believes that the scope of the mission will likely be defined by the frequency of Earth-like worlds. The question is how many stars does TPF have to sample to provide a meaningful result. Dr. Beichman believes that to reach certainty of finding out what you want, the TPF has to keep going until one finds 150 stars. To provide a meaningful null result, TPF has to sample at least 50 stars that are likely homes to Earths.

Dr. Dressler turned to the history of the JWST. Originally, it was conceived of as a 4-meter cold telescope, with a cost target of $500 million in Phase c/d. In 1997, NASA engineers were challenged to build an 8-meter telescope for the same cost. GSFC confirmed the feasibility of a $500 million target budget. When CSA and ESA become project partners, the budget rose to $750 million. In 2001, the NRC astrophysics decadal survey selected JWST as the highest rated project for the decade and emphasized the importance of including mid-infrared capability (MIRI). Currently, OSS is faced with a $1.6 billion budget with a $300 million overrun. The JWST Science Working Group (SWG) agreed to a reduction of aperture to 7-meter or 6-meter in the hope of saving the MIRI. A loss of up to 50 percent of the science capability will result in only a 2 percent reduction in the budget. The OS thinks that this is not a good trade. The best result for the replan is still $100 million over budget, which is the approximate budget of the MIRI. Last week, the OS reaffirmed the critical importance of MIRI to the mission. In fact, all groups that have weighed in consider it essential to keep the MIRI in the program. Explaining why the MIRI is considered so important to JWST's success, Dr. Dressler recounted that JWST's prime goal is to be able to see first generation stars. Young starlight can be seen in 1-5μm range, but giant stars, dusty star formation regions require 10-20 μm, for which the MIRI is needed. Dr. Dressler stressed that a 4-meter, cold telescope will not allow the gathering of information needed by other projects and that this will ripple through the whole space program. He thinks that this project is essential to the origins quest. In addition, the scope of this telescope was greatly increased. The Origins Subcommittee endorses the MIRI as an essential part of the program, and agree that there will be a $100 million overage.

Discussion

Dr. Mould proffered that Dr. Lunine would have supported this report if he had not been obliged to leave the meeting. Dr. Mould proposed that the Committee say that the JWST should not be so constrained by budget at this stage. Dr. Hammel noted that most of the science drivers in this project are not within the Solar System community. She pointed out that they did reduce the resolution for cost reduction, but there were not substantial money gains with the reduction of size. From a science point of view, she stated that it is better to delay the launch date then to reduce the quality of the science and instrument.

Dr. McComas reminded the group that an independent cost review would be received in a couple of months. He thinks that no science should be given up until the cost assessment is received. It is important to keep in mind that this was the highest recommended project in the NRC decadal survey. Dr. Illingworth thought that reducing the science capability by 30 to 50 percent with only a 2 percent budget reduction is not a wise decision. There is an 8-year timeframe before launch, and much can happen during that time, including increasing costs.

The Committee decided that Dr. Illingworth would help Dr. Dressler write a recommendation supporting keeping the MIRI. The Chair told the SScAC that Dr. Dressler's term was over at the end of this meeting and thanked Dr. Dressler for all his contributions as the OS Chair and as a member of this Committee.

Space Science Enterprise Strategy 2003

Dr. Marc Allen, Director for Strategic and International Planning and Lisa May, reviewed in detail the 2003 strategic planning process, schedule, and structure of the space science strategy, as well as the theme section and technology content. Each SScAC member and subcommittee received a copy of the draft for review.

Dr. Allen relayed that Administrator O'Keefe is very interested in a top-down plan with full-cost accounting and related to NASA's 18 themes. OSS has responsibility for five themes. OMB wants the Agency's objectives to be more measurable. Executive review may change our wording; they have the final decisions. OSS has done well in developing our plans because we have been doing this the same way for years. However, not all Enterprises had done this type of planning previously, and it has proven to be difficult for them.

Dr. Kolb asked if we are setting policy in this plan, that is, if something is said in this plan, does that then become policy? As an example, Dr. Kolb identified where it states there is a 6 months time frame to release data. He was told that Dr. Weiler strongly supports this as a policy. In international negotiations, we need this policy so data will get out. Dr. Kolb said that SEUS was uncomfortable with parts and was submitting a rewrite.

Dr. Dressler had a list of suggested changes from the Origins Subcommittee that he went over and will submit to Ms. May. Overall, they thought the plan was good. However, OS is concerned that on page 14, theory was defined as merely modeling. The importance of theoretical work needs to be explained; it enables analysis of data. The phrase "as only NASA can" should be used sparingly, as there are many sources of inspiration. In addition, we should not use this phrase in a negative way. Dr. Allen said it is used to explain why NASA is not going to do something–if it is not something that NASA is uniquely able to do.

Dr. Hammel said that she had many rewrite suggestions that would be sent in. Dr. Hathaway did not think supporting content stood out sufficiently. Ms. May identified that more supporting content is in the appendix. Dr. Hathaway wondered why all this good material was placed in the appendix. Ms. May responded that content to support the theme and research focus area is located immediately after in the text. The appendix contains additional supporting content, which had it been included in the body of the plan, would have made the plan's structure too complex.

Dr. McComas said SECAS reviewed the draft and made many suggestions, which will be submitted in writing. He did relay the larger issues, however. They were: No mention of the Sun-Earth technologies in the summary, barely mentioned in technology section; they suggested a box telling highlights and added graphics; they suggested a paragraph on national space weather program; Key External Factors – added words to address problems that were mentioned but not addressed; and recommend removal of the triennial program reviews discussion.

Dr. Mustard suggested that R & A have a punchier explanation, and he offered to write it. Dr. Beichman was asked to write introductory sentences for astrobiology and agreed to do so.

Ms. May gave a March 17 deadline for all comments, suggestions, and rewrites. She requested that comments **not** be put into the document electronically, but emailed to her with page numbers referenced.

Education Task Force Report

Dr. Paul Knappenberger, President of the Adler Planetarium and Chair of the Education Task Force, explained that the Education/Public Opinion (E/PO) Program Task Force was charged with assessing how well OSS had done in carrying out the E/PO Implementation Plan and identifying needed adjustments in the approach. After reviewing numerous materials, interviewing many people, and meeting several times, the Education Task Force found that the E/PO Program's innovative, process-oriented approach has made substantial progress over the past six years, including these accomplishments and successes: direct engagement of OSS missions and the space science research community in education; a rich harvest of education programs and materials for many types of audiences in diverse communities across the country; significant steps toward involving minorities in the mainstream of its scientific, technical, and education programs and developing education materials directed towards audiences that have not previously been served by NASA; and leveraging resources through

collaboration with hundreds of institutions across the country. The program is a credit both to the OSS and to all of the people who have been involved in its planning and execution.

To build on this progress, the Task Force made recommendations for the program's future evolution, including: provide greater coherence and accessibility for its educational products through the creation of a space science framework; be more inclusive in its audiences, science topics, materials and partnerships; increase and better integrate minorities in E/PO projects and into the mainstream of OSS science programs; put more focus on quality control and on a better understanding of program impact; fine-tune the Support Network by making sure the Broker/Facilitators focus on their primary role; strengthen and expand professional development efforts for E/PO professionals, educators and scientists; enhance internal and external communications; and identify and acquire resources for sustainability.

The OSS E/PO program, with its established productive partnership between the space science and education communities and its use of a national network to identify and sustain high-leverage opportunities, should serve as a guide for future NASA educational efforts. It effectively utilizes inspirations that come from scientific discoveries. It has invested taxpayers' resources wisely in programs geared towards replenishing the technological workforce.

The Education Task Force recommended that the OSS E/PO program should be improved and not disrupted. The Task Force study shows that its success could only have been accomplished from within OSS. Engaging the missions and the research community required strong commitment from and direct involvement of OSS top management. OSS has built education into all aspects of OSS planning and decision-making, from strategic planning and budget formulation to mission proposal review and selection to the production and dissemination of education products and programs themselves. A large percentage of the funding comes from a direct "levy" on OSS missions and giving investigators strong incentives to develop collaborations with the education community and, through those collaborations, deliver usable education products that are both based on the needs of the education community and the unique involvement of the space science community. These steps have led to close and effective partnerships between the science and education communities and have been a necessary condition for the program's success to date.

NASA's new Office of Education has the potential to create a holistic picture for space science education and to establish strong collaborative partnerships in education across the enterprises. It can also forge cooperative links with programs of professional organizations such as AAS, AGU, NSTA, and partnerships with government agencies including NSF, DOE, DoEd. However, the Task Force cautioned that the administrative convenience and efficiency that a centralized Education Enterprise might provide could have the unintended consequence of disrupting critical relationships (existing and potential) with both the scientific and educational communities. The imposition of added administrative layers of bureaucracy could degrade the flexibility of the OSS program that has by design been opportunistic.

Discussion

Dr. Mould pointed out that NSF has more educational resources now, but any grant application submitted to them has to include a statement of its broader implications and impact. For this program to have larger impact, it must train teachers. This can be a focused effort, as only 25 colleges train the majority of teachers. NASA should design curricula and programs for a Masters in Space Science education, a Teaching Certification in Space Science, and a major in Space Science within an undergraduate education degree. In addition, NASA should establish research experiences for non-science majors. All of these efforts and programs should be coordinated to maximize benefits.

A SScAC member expressed concern about centralizing the NASA educational programs. OSS has the premier education program in NASA. OSS should have a part in shaping the new Education Enterprise and forming their framework. The Chair requested a summary and charts on this to present at the NAC meeting in 2 weeks.

The Chair thanked Dr. Knappenberger for his Task Force's thorough work and excellent analysis.

Sun-Earth Connections Division Report

Dr. Richard Fisher, Sun-Earth Connections (SEC) Division Director, began his presentation by observing that while the SEC FY 2004 budget allocation increased generously to $769.8 million (19 percent of the OSS budget), it still does not fully support all of their programs. He continued with a review of the current SEC Division missions.

Dr. Fisher named additional missions that are under consideration for development in the next 5 years. He continued by enumerating the goals and objectives for which SEC is responsible. The two OSS Agency Strategic Plan components are "Goal 1: Understand the Earth system and apply Earth system science to improve prediction of climate, weather and natural hazards"; and "Goal 5: Explore the solar system and the universe beyond, understand the origin and evolution of life, and search for evidence of life elsewhere." The SEC Division scientific objectives are to:

- Understand how the sun, heliosphere, and the planets are connected in a single system.
- Explore the fundamental physical processes of plasma systems in the universe
- Understand the changing flow of energy & matter throughout the sun, heliosphere, and planetary environments
- Define the origins and societal impacts of variability in the Sun-Earth Connection

The SEC Division is optimistic that it will be possible to use nuclear power for the Solar Probe mission, which has a tentative launch date in 2013. The NRC SEC decadal survey considered the Solar Probe the highest priority for SEC. The SECAS also gave it the highest priority. The Division is currently writing a plan to aggressively pursue strategic elements to implement the L1 Cluster activity, which includes the Solar Probe, STEREO, and MMS.

The SEC NRC decadal survey strongly urged NASA to engage all organizations that utilize solar wind variables, either for basic science or for space weather applications. The report noted that the informal activities initiated by OSS were a good start, but thought that a more formal mechanism may be required. Discussions would identify the responsible agency and the methodology by which monitoring of the interplanetary environment at L1 will be accomplished and maintained.

Dr. Fisher reported to the SScAC what related activities have taken place. In Fall 2002, Dr. Fisher accepted the position of Co-Chair on the Committee For Space Weather (SWx). The SEC decadal survey recommendations were reviewed and L1 circumstances discussed by SWx partners at the January 2003 SWx meeting. During the winter, NASA initiated discussions concerning transitioning the ACE spacecraft to NOAA. During that time, NOAA's SXI solar X-ray telescope facility became operational, and they indicated their intention to seek a new operational facility at L1, with a launch date of late 2008 or early 2009. NOAA decided to take "ownership" of L1. Dr. Christensen requested a document from NOAA committing to do this. He noted that we also must determine if NOAA will measure what NASA needs measured. Dr. Beichman suggested that NOAA be requested to include a SEC expert as part of their program. This would strengthen the link between NASA and NOAA. NASA depends on NOAA to supply NASA with data and information on space weather for the Space Station. Dr. Christensen offered to identify who at NOAA has the power to include NASA in their work on the new operational facility at L1. The contact name will be supplied to OSS.

Dr. Fisher continued his presentation with an explanation of the Living With a Star (LWS) Program and the Geospace Program. The crux of LWS is that it takes a systems approach. It focuses on our Sun-Earth region as one system. He then reviewed the mission and charter of the International Living with a Star Working Group (ILWS-WG). Dr. Fisher concluded his presentation by describing the SEC educational activities, forum, and web site. They have a very dynamic program, with a website that is visually exciting with glorious, ever changing photographs of the Sun, its activity, the aurora, etc. There is an annual national Sun-Earth Day celebration and an Aurora Sun-Earth Day celebration. Up to 164 organizations participate in these celebrations, including 10 NASA Centers and 31 states. More than 100,000 people from the public

participate. SEC trains and provides materials and web information to 8,000 educators and 8 million students annually. They distribute more than 10,000 educational products. SEC has an extremely successful outreach program to scientists and amateur astronomers: more than 500 per year participate in SEC's programs. Amateur astronomers have made many contributions to finding comets using SOHO data. The SEC Website has 10 million hits annually. SEC organizes and conducts many high visibility national events involving hundreds of scientists. SEC events generate an enormous amount of TV/radio/newspaper coverage, up to 100 million annually through NASA TV, CNN and other national networks and newspapers.

Dr. Hammel complimented Dr. Fisher on his presentation and visuals. She was impressed about how much is going on to study the Sun. She thought that the science program information was not getting out well enough. Dr. Fisher noted that they receive tremendous coverage in *Discovery, Popular Science*, the evening news, *CNN*, etc. Dr. McComas noted that it is often difficult to tell the story simply enough so that the media would want to pick it up. Dr. Fisher agrees and has gotten support from OSS whenever there are legitimate news stories.

Sun-Earth Connections Advisory Subcommittee Report

Dr. David McComas, Southwest Research Institute, Chair, Sun-Earth Connections Advisory Subcommittee (SECAS), summarized the SECAS review of SEC programs.

Solar Probe Mission

The Solar Probe will answer key questions about the heating of the corona and acceleration of the solar wind that can be answered in no other way. Recent progress from SOHO, Ulysses, WIND and ACE has contributed to our understanding of the corona and solar wind, making the need for Solar Probe observations clearer and more urgent. The NRC's decadal survey and NASA's SEC Roadmap have both given high priority to the Solar Probe mission. There is widespread community support for the Solar Probe mission.

Significant new expertise was gained through experience of the teams that responded to the Solar Probe AO. The 2002 Engineering Study performed by APL and JPL indicates that significantly more mass, power and telemetry will be available to the science payload. Because of the technical challenges of this mission, there is a need to retire risks now through technology development.

In view of these developments, the SECAS recommends that NASA convene a new Science and Technology Definition Team (STDT). This team must address the trade-offs among cost, technological constraints and scientific objectives and develop a mission concept that achieves the break-through Solar Probe science. It is, therefore, important that this team include people from the community who have experience with the specific technological challenges and the various scientific opportunities afforded by the Solar Probe mission. This STDT effort must be integrated with the spacecraft and mission studies, which may require more resources than a traditional science definition team.

Jupiter Polar Orbiter Science Definition Team

SECAS would also like to emphasize the priority of a Jupiter mission. Jupiter offers us the opportunity to study magnetosphere-ionosphere coupling in a rapidly rotating magnetosphere. Unlike the Earth's magnetosphere, which is powered primarily by the solar wind, Jupiter's magnetosphere is powered by planetary rotation. At Jupiter, the primary energy reservoir is Jupiter's rotating plasma disk. A frictional torque in the atmosphere is thought to accelerate Jovian plasma to rotation. This torque is transmitted to the Jovian magnetosphere by field-aligned currents that are thought to be the source of Jupiter's powerful aurora. The proposed Jupiter Polar Orbiter mission will allow us to make *in situ* observations of the current carrying region while imaging the aurora, thereby directly observing the physical processes that drive this coupling between the plasma disk and Jupiter's atmosphere. This mission will provide critical measurements for understanding the physics of rapidly rotating planetary bodies. SECAS recommends that NASA undertake a science and technology definition study of an SEC-focused Jupiter Polar Orbiter mission as the next step in clarifying the science priorities in the context of mission options. Optimal timing for completion of such a study would be one year.

Role of Explorer Missions in SEC Science

SECAS reaffirms the vital importance of the Explorer mission line for Sun-Earth Connection science. Explorer missions enable frequent opportunities for compelling, focused science questions to be addressed with small- and medium-sized missions (SMEX and MIDEX) that can be developed and launched in short (approximately four-year) timeframes. The Explorer mission line provides important opportunities to respond quickly to new scientific and technical developments and to augment the larger strategic Solar-Terrestrial Probes and Living with a Star missions. SECAS underscored the need to allocate sufficient resources to the Explorer line to assure predictable availability, long-term stability, and measured growth. It is a credit to the Explorer line that the best science is accomplished through competitive selection across OSS themes. Sun-Earth Connection science advancements rely heavily on that community's continued success in these competitions.

ST-5 Technology Demonstration

SECAS continues to strongly endorse the ST-5 project as a vital pathfinding demonstration for Sun-Earth Connection missions requiring resource-limited microsatellites. The three-spacecraft ST-5 flight mission configuration will validate mission-critical elements (listed in priority order with the first two of nearly equal priority) needed urgently for Magnetospheric Constellation and several other multi-spacecraft SEC missions in the STP queue. These elements include 25-kg-class satellites, employing and validating new technologies and capable of research-quality measurements; economy of scale in the fabrication of multiple, small satellites; and that technical issues associated with the operation of a trail-blazing GTO constellation can be explored and assessed.

To ensure the realization of all three of these mission-enabling goals, SECAS reaffirmed its earlier strong recommendation to complete the three-satellite-configuration ST-5 flight project as originally proposed.

SECAS also recommends that the ST-5 project publicize (e.g., via web pages) the valuable results of its technology developments to the SEC community. The Subcommittee applauds ST-5's considerable successes in developing technologies relevant to the Sun-Earth connection, but are concerned that these developments are not as widely known as they should be. It urged broad dissemination of the status of these technologies in order to fully reap their benefits for planned and future Sun-Earth connection missions.

Sounding Rockets

For over four decades, NASA's sounding rocket program has provided three vital functions for NASA space science: focused, cutting-edge science experiments; platforms for instrument development; and a unique means of training young scientists and engineers, especially undergraduate and graduate students. Development of high altitude (1,000 miles) sounding rockets (HASR) provides a significant new capability for doing Sun-Earth Connection science. High-altitude and long-duration observations at a constrained geophysical location enables, for example, studies of radiation belts; the auroral acceleration region; and astronomical targets, including the Sun and comets.

SECAS strongly endorses the HASR development, which also promises to fill a gap in NASA's access to space between traditional low-altitude rockets and the SMEX program. This development should proceed at the most expeditious pace consistent with maintaining a constant or increased launch rate for all rockets and maintenance of a solid inventory of rocket motors and subsystems capable of supporting the rocket research program.

Small Launcher Access to Space

SECAS appreciated the briefing by Drs. Karen Poniatowski and Steve Clark. This briefing highlighted many of the issues with the small end of NASA's space launch capability. The lack of low cost launch capability available and permissible for smaller NASA missions continues to be the single largest barrier to be overcome in carrying out the Sun-Earth Connection program. Probably more so than any of the other space science disciplines, SEC depends for much of its strategic program on regular, reliable, low-cost access to

space on small launch vehicles and as secondary payloads on other larger launches. While the desire to protect U.S. launch suppliers against competition from overseas companies and institutions is understood, it is not clear what is to be gained by protecting a area where there is no other significant market. SECAS urged NASA to redouble its efforts to explore innovative ways to preserve and expand the capability for launching small payloads in order to mitigate this critical and urgent problem.

Finally, SECAS was gratified to have Dr. Weiler visit and share his perspective on the larger OSS program. Of particular interest were the new nuclear mission concept and instrumentation NRAs that will solicit input on possible Jupiter missions and observations and other missions and observations that may be enabled by the greatly increased power available from Prometheus. SECAS believes that the SEC community may have much to offer to both the nuclear and Jupiter mission studies and urges NASA to make sure that these NRAs and their review processes are drawn sufficiently broadly that SEC input can be fully solicited and incorporated into these programs.

Discussion

Dr. Christensen identified several topics for committee discussion:
1. Federal Advisory Committee Act (FACA)-Whether the SScAC subcommittees should be chartered as FACA committees. To fully realize the depth and specificity of their knowledge and informed recommendations, should the subcommittees be chartered so they can legally report directly to the Government?

Dr. Kinney said she supported chartering, because she needs people who delve into their subjects in depth and take the time to give her the depth of work and advice that she needs. Others present also supported having the broader advice and a larger support and advocacy base. SScAC wanted to know what the other NASA Enterprises are doing with their subcommittees. OSS is the only one that has more than one FACA committee (the other is the Planetary Protection Advisory Committee).

If the subcommittees remain unchartered, OSS will need to evolve rules on how they should operate.
The members said they like having open meetings. The decision was to support making them chartered.

2. Balloons – According to Anne Kinney's SEUS report, balloons for scientific research are becoming less available. They help train students and offer a nearspace environment, which might be valuable, but at what costs. Is it a SEUS problem or broader? SScAC wants to discuss the use of balloons. In order to do that intelligently, a rocket vs. balloon talk is needed sometime in the future.

3. Radioastron – This has been discussed since the 1980's. An international agreement with Russia exists. The U.S. had agreed to support four ground terminals to do the tracking and orbit determination, as well as support for various working groups. The ground terminals were used to support the Japanese VSOP Mission, but that mission is over, and the terminals have now been deactivated. Radioastron was supposed to fly in 2000, but launch will now be in 2006 or later. The original agreement did not have an expiration date, very unusual. NASA has not budgeted for this mission since 2000. There are legal ways of withdrawing from the project, but terminating the U.S. participation in this mission will have some costs.

Dr. Kolb reported that the SEUS considered installing off-ramp clauses in a new Memorandum of Understanding, as they were not confident the 2006 launch date could be accomplished. The subcommittee considered the opportunity cost of the needed $12 million over the next few years (for a single ground station), and concluded that the money would be better spent even on other radio interferometry projects. As a result, they recommended against development of a new MOU

Dr. McComas stressed that the cost of termination is long range and political. NASA needs to take international commitments very seriously. There are serious, long-term negative implications to cancellation of an international agreement. There was discussion of this impact and project cost vis à vis funding for some other important programs.

Dr. Allen told the Committee that OSS staff had been to Russia three times since early September for discussions. There's doubt the project will be ready by 2006. But he said that the question for the SScAC has to do with the science–is it valuable enough to continue with the project? Scientifically, what would be the best thing to do? NASA will have to make the budget decisions; the political factors should not be the concern of this Committee. From a science standpoint, if NASA were to proceed, it would be necessary to rework the program with Russia so it can move forward.

Dr. Kolb presented a paragraph that stated that the subcommittee had been asked to take a look at the science benefit versus cost situation for the mission. The summary stated that the subcommittee had looked at the science opportunity on Radioastron and compared it to other funded activities and they had come up with a clear science conclusion. Then the paragraph went on to say that after its consideration, the subcommittee did not endorse renegotiating the MOU. After discussion, Dr. Kolb recommended that the SScAC's advice focus on the SEUS science assessment and omit the discussion of renegotiation.

Chairman Christensen felt that the SScAC should support the decision of the subcommittee, and it did so.

4. Prometheus – Using this mission and method to explore Jupiter's icy moons coincides with the NRC planetary decadal survey recommendations for exploration of Europa. NASA should engage the community in this early. It is good that a workshop is already planned. NASA ought to put together a document telling what this nuclear power would enable– what types of projects, missions, science. It also needs to link the technology to the science.

Dr. Hammel expressed a concern within the solar system science community about money going to technology, draining away science money. OSS needs to link the relationship of the technology with the science to help alleviate this anxiety.

The decision was that SScAC will support community involvement and explaining the link of technology with science.

The SScAC suggested that an advisory body should be established for Prometheus. NASA should establish a task force with experts in nuclear systems, because SScAC does not have this expertise. The SScAC has great enthusiasm for this project, as long as there is nuclear power expertise.

5. Small Launcher Availability/Low Cost Access To Space – Drs. Hathaway and McComas are very worried that small launchers won't be available when needed. Dr. Kress pointed out that the issue of assured access and consequences of unavailability have not been dealt with. Pegasus is the only program of small rockets now. If it is discontinued, small rockets won't be available when needed. More Deltas will be bought so those small launchers should available. The Chair worried that researchers will be told to adapt to the new environment and partner to use big launchers, rather than producing the smaller rockets. Private business is going out of this business because they are not getting enough orders. Dr. McComas responded that maybe NASA should start producing the small rockets, as it used to, or perhaps NASA will have to buy them from a foreign company. Congress would have to allow it. Perhaps NASA will have to use a U.S. company to procure the foreign rockets for us, and then have the U.S. company sell them to NASA. The decision was to discuss this issue with the NAC and to urge long-term support for access to small rockets.

6. R&A – Flat funding
There should be more general R&A money. Dr. Hammel said good science was not being done, because there isn't adequate funding. Good scientists are leaving the field because they cannot get funding. What will that mean for the future? Dr. Weiler will support R&A increases, but only if they are linked to a program. That is how he has retained R&A. Someone queried where is the R&A component of JIMO? It needs to be built into this program, but it is vulnerable if it has an R&A imprimatur. Perhaps a report should be prepared explaining how R&A leads to the ability to do cutting edge science and to show what

accomplishments were a result of the R&A funding and findings. Science communities generally do not understand how R & A or the lack of it works. NASA needs to do a better job of explaining R & A to the science communities.

Wednesday, March 5

Preparation of Committee Letter

Dr. Christensen welcomed everyone to the last day of the meeting and thanked everyone for all their hard work. The Committee set new meeting dates. They are:

SScAC Meeting Dates

Date: August 11-13, 2003 Location: Headquarters in Washington, DC
Date: November 17-19, 2003 Location: Ames Research Center)

JWST

Dr. Christensen convened a discussion about JWST. The SScAC is concerned about the mission redesign and the budget. SScAC thinks it is premature to think of compromising and reducing the science. There needs to be an independent cost analysis first. Concern about MIRI in particular was expressed. Members thought NASA should assess the science. The science community scoped this project 10 years ago, and many changes have occurred which should alter the original plan. Members were bothered by the potential reduction of capability without knowing what the technological and dollar costs were. The Committee felt it important to talk about this with Dr. Weiler.

Dr. Christensen led the Committee in drafting a letter of recommendations and concern to be sent to Dr. Weiler on behalf of the SScAC. (Appendix D)

Report to AA (Via Video Conference)

Dr. Christensen expressed appreciation to Ed Weiler about the extensive and excellent staff presentations and the impressive gains for the field. The Chair reviewed the Committee's discussions, conclusions, and recommendations. He noted the following topics: low cost access to space, Prometheus, the OSS Draft Strategic Plan, the Educational Task Force report and recommendations, chartering of SScAC subcommittees, JWST, and R&A funds. Dr. Christensen then reviewed the committee's draft letter's main points.

Dr. Christensen addressed the low cost access to space issue. He expressed appreciation for the staff's thoroughness and forward thinking to ensure access to small launch vehicles for the next five years. There are problems and challenges in moving to larger vehicles. SScAC wants to put this on the NAC agenda to discuss what to do if there are no U.S. manufacturers after five years who produce small rockets.

Concerning Prometheus, the SScAC expressed concern that we do not have any nuclear expertise on this advisory body. A subcommittee with experts in nuclear systems should be established to advise in this area. Dr. Weiler said that NASA realizes that this is a very complex project, and that is why there won't be a launch for many years. At HQ, we have 4 to 5 staff who worked with Adm. Rickover, and at JPL, we have one. As a result, Dr. Weiler feels confident with our knowledge base. The Department of Energy is very interested in this, because this is their future. Dr. Christensen expressed the Committee's enthusiasm for the project and hoped that there will be broad and multidisciplinary interest.

SScAC members have reviewed the draft OSS strategic plan. They were pleased at its current status and will provide additional comments in the next two weeks. The Chair asked Dr. Weiler to clarify what is meant by "data are to be released within 6 months." Is that 6 months after data collection or data validation? Dr. Weiler relayed that there are 3 factions on this issue: immediate release, as soon as possible, and keep for a long time. Each mission has to be looked at on a case-by-case basis. The plan seems to state an absolute requirement. Dr.

Weiler clarified that it is just a general rule. But there is a need for such a policy, particularly for international cooperative missions.

In regard to the findings of the Education Task Force, there is still concern about the ultimate relationship between OSS and the Education Enterprise (Code N). What is Dr. Weiler's opinion? The education money will stay with the individual enterprise, but will be overseen by Code N staff. If someone is writing an NRA for OSS money, OSS will have something to say about it. OSS money will be used for OSS education. The personnel in OSS will remain the same. OSS has set the pace for education in NASA and SScAC thought OSS should have a leadership role. The Administrator has set some national goals that Code N is responsible for instituting. OSS and Code N will have to be flexible, and there will be a successful working relationship.

Turning to FACA, SScAC supported chartering the subcommittees under FACA. The division directors were polled and opinions ranged from support to positive endorsement.

In addressing the JWST issue, Dr. Christensen expressed the Committee's concern about the mission redesign and the budget. SScAC thought it was premature to think of compromising and reducing the science. There needs to be an independent cost analysis first. Concern about MIRI, in particular, was expressed. Dr. Weiler informed the SScAC that the MIRI was not in the original concept. It was added afterward. He thought that MIRI would eventually cost $200 million or more. Dr. Weiler said there have already been independent cost reviews. The next one is just an additional one. If the problem is more than $300 million, there won't be a JWST. The overruns are basically because of add-ons. If the community insists on a multiuse telescope, it will have to wait many years. Dr. Weiler informed the SScAC that near-infrared, and not mid-infrared, is where the action will be in the future. Dr. Christensen asked why was the Committee told that mid infrared would be the most important? If the community pushed for the MIRI, realistically, we may not get a JWST until a generation from now. And if they ask for money for another Hubble servicing mission, we will lose the JWST then, too.

In past years, R&A had an inflation rate built in. That did not occur this year. Now that the inclusion of R&A in each mission is under a different name, Dr. Christensen asked how would this affect the amount of R&A money? Dr. Weiler explained that R&A funding increased by $16 million in FY04. Old programs R&A was frozen in FY04, but new programs are getting more R&A monies. In fact, in FY 05, it is increased by 20 percent; $871 million is going to universities and scientific communities over the next several years. The SScAC was very pleased with this clarification, and will drop the matter. However, Dr. Christensen suggested that this information be given to the community so they understand it. It is too hard to find it in the budget. This concluded this segment of the meeting.

Topics for Next Meeting:

- A briefing on suborbital issues, status, and programs
- A presentation on NASA's efforts to retain/enable low cost access to space
- A report on the outcome of the Gravity Probe B Panel recommendations
- How JIMO is implementing the NRC Planetary decadal survey's recommendation.
- A detailed briefing on R & A budget commitments
- A rocket vs. balloon explanation session

Adjourn

Dr. Christensen thanked the members for their individual contributions to the meeting and to the work of the SScAC. He assured the members that he would report SScAC's recommendations to the NASA Advisory Committee at the upcoming meeting.

Dr. Christensen then thanked the E/PO Education Task Force for their hard work. He also thanked Mr. Newhouse for his detailed presentation. At this point, Dr. Christensen adjourned the meeting.

Space Science Advisory Committee
Jet Propulsion Laboratory, Bldg 180, Room 141
Pasadena, California
March 3-5, 2003

AGENDA

Monday, March 3

8:30	Welcome	Charles Elachi
8:40	Opening Remarks	Andrew Christensen
9:00	FY04 Budget Presentation and Q&A	Edward Weiler
10:45	BREAK	
11:00	A&P Division Report	Anne Kinney
Noon	IRTF: Six Weeks to Launch	Michael Werner
1:00	Launch Services Outlook (VITS)	Karen Poniatowski
2:00	SEUS Report and Discussion	Edward W. Kolb
3:00	BREAK	
3:15	Project Prometheus, the Nuclear Program	Alan Newhouse
3:45	Solar System Exploration Division Report	Colleen Hartman
4:45	Mars Program Office report	Orlando Figueroa
6:00	ADJOURN	
6:30	Committee Dinner at Café Santorini	

Tuesday, March 4

8:30	SSES Report and Discussion	Jonathan Lunine
9:30	Origins Subcommittee (OS) Report	Alan Dressler
10:30	BREAK	
10:45	Space Science Enterprise Strategy 2003	Marc Allen /Lisa May
11:30	General Committee Discussion	
Noon	LUNCH	
1:00	Education (E/PO) Task Force Report	Paul Knappenberger
2:00	Sun-Earth Connection Division Report	Robert Fisher
2:45	BREAK	
3:00	SECAS Report and Discussion	David McComas
4:00	General Committee Discussion	Andrew Christensen
5:30	ADJOURN	

Wednesday, March 5

8:30	Preparation of Committee Letter	Andrew Christensen
10:00	Report to AA (VITS)	Andrew Christensen
11:00	ADJOURN	

(As of 2/21/03)
SPACE SCIENCE ADVISORY COMMITTEE (SScAC)

MEMBERSHIP LIST

Dr. Andrew B. Christensen (Chair)
The Aerospace Corporation

Dr. David L. Akin
Space Systems Laboratory

Dr. Charles A. Beichman
Jet Propulsion Laboratory

Dr. Alok Das
Air Force Research Laboratory

Dr. David W. Deamer
Department of Chemistry and Biochmestry
University of California

Dr. Alan M. Dressler
Carnegie Observatories
Carnegie Institution of Washington

Dr. Jack D. Farmer
Department of Geology
Arizona State University

Dr. Heidi B. Hammel
Space Science Institute

Dr. David H. Hathaway
Marshall Space Flight Center

Dr. Roderick A. Heelis
William B. Hanson Center for Space Sciences
University of Texas at Dallas

Dr. Garth D. Illingworth
Department of Astronomy and Astropysics
University of California, Santa Cruz

Dr. Judith T. Karpen
Naval Research Laboratory

Dr. Paul H. Knappenberger
Adler Planetarium and Astronomy

Dr. Edward W. Kolb
Theoretical Astrophysics
Fermi National Accelerator Laboratory

Mr. Martin P. Kress
Battelle Memorial Institute

Dr. Jonathan I. Lunine
University of Arizona

Dr. David J. McComas
Southwest Research Institute

Dr. Jeremy R. Mould
National Optical Astronomy Observatory

Dr. John F. Mustard
Department of Geological Sciences
Brown University

Dr. Marc S. Allen (Designated Federal Official)
NASA Headquarters

Ms. Marian R. Norris (Administrative Officer)
NASA Headquarters

Pending Member:

Dr. David N. Spergel
Department of Astrophysical Sciences
Princeton University

Space Science Advisory Committee
Jet Propulsion Laboratory, Bldg 180, Room 141
Pasadena, California
March 3-5, 2003

MEETING ATTENDEES

Committee Members

Dr. Andrew B. Christensen (*Chair*)	The Aerospace Corporation
Dr. David H. Hathaway	National Aeronautics and Space Administration
Dr. Charles A. Beichman	Jet Propulsion Laboratory, National Aeronautics and Space Administration
Dr. Alok Das	Air Force Research Laboratory
Dr. Alan M. Dressler	Carnegie Observatories, Carnegie Institution of Washington
Dr. David H. Hathaway	Marshall Space Flight Center, National Aeronautics and Space Administration
Dr. Heidi B. Hammel	Space Science Institute
Dr. Roderick A. Heelis	University of Texas at Dallas
Dr. Garth D. Illingworth	University of California, Santa Cruz
Dr. Paul H. Knappenberger	Adler Planetarium and Astronomy Museum
Dr. Edward W. Kolb	Fermi National Accelerator Laboratory
Mr. Martin P. Kress	Battelle Memorial Institute
Dr. Jonathan I. Lunine	University of Arizona
Dr. David J. McComas	Southwest Research Institute
Dr. Jeremy R. Mould	National Optical Astronomy Observatory
Dr. John F. Mustard	Brown University
Dr. Marc Allen (*Executive Secretary*)	NASA Headquarters

NASA Headquarters Attendees

Bauer, David
Bohlin, David
Figueroa, Orlando
Fisher, Richard
Hartman, Colleen
May, Lisa
Newhouse, Alan
Norris, Marian
Rosendhal, Jeffrey
Thronson, Harley
Trotta, Ann Marie
Weiler, Edward

NASA Jet Propulsion Laboratory Attendees

Abraham, Douglas
Antonsson, E.
Asdund, Shari
Bolton, Scott
Breckinridge, Jim
Cesarone, Robert
Chahine, Mous
Devivius, M.
Ferraro, Kay
Frederick, Suzanne
Kulezycki, Stephen
Nelson, Robert
Prince, Tom
Prusha, Steve
Sohus, Anita
Weber, Carl
Werner, Michael

NASA Attendees

Riegler, Guenter	Ames Research Center
Six, Frank	Marshall Space Flight Center

Other Attendees

Dr. David N. Spergel	Princeton University
Purdy, William	Ball Aerospace

SPACE SCIENCE ADVISORY COMMITTEE REPORT

April 2, 2003

Dr. Edward Weiler
Associate Administrator for Space Science
NASA Headquarters
Washington, DC 20546

Dear Dr. Weiler,

I am pleased to provide you a summary of the Space Science Advisory Committee (SScAC) meeting held in public session March 3-5, 2003 at NASA/JPL. In addition, I am including the final report of the E/PO Task Force as well as the subcommittee reports from SEUS, SECAS, OS, and SSES.

Our meeting began with a warm welcome to the facility by Dr. Charles Elachi. We enjoyed the wonderful facilities and the excellent technical support provided by the JPL personnel during our visit.

During your briefing on the budget, we were pleased to learn about new content in the FY 04 budget: Project Prometheus, Optical Communications, and elements of the Beyond Einstein program. This is a clear indication of the outstanding leadership and effectiveness of you and your staff for fostering a healthy and exciting domestic and international space science endeavor.

We heard from members of your staff and we were impressed with the degree of scientific progress across the disciplines. It is interesting to note that the management issues brought before us were based primarily on the growing number and complexity of the programs, indicative of the vibrant and growing science activities in OSS. The presentations by Anne Kinney, Colleen Hartman, Orlando Figueroa and Richard Fisher were interesting, informative and sometimes entertaining. We appreciate their candor and willingness to share their concerns with us.

The meeting was organized around presentations by the Division Directors followed by briefings by the Subcommittee chairs. This structure allowed SScAC to review the subcommittee recommendations in accordance with FACA regulations. We also greatly appreciated the excellent presentation by Karen Poniatowski in response to our request for an update on the launch availability issue. The committee is eager to help insure continued access to space for our small and mid-class payloads and welcome Karen's invitation for continued dialog.

Al Newhouse's energetic presentation regarding the new Prometheus project was very well received. Specific issues related to his presentation are included in the comments and recommendations summarized below.

And finally, the SScAC wishes to express appreciation to Paul Knappenberger and his E/PO task force for their outstanding report on the status of the OSS E/PO activities.

Specific comments and recommendations follow.

FACA Charter

The SScAC discussed the pros and cons of FACA status for its four subcommittees. Non-FACA status would reduce the paperwork burden on NASA and the committee members and eliminate the need for open meetings and public notification of meetings. Recommendations however would need to be passed to the SScAC for approval and forwarded to the Division Directors. Responding effectively to the level of detail involved in the very different programs and constituencies in each of the themes then becomes a challenge for a single committee such as SScAC. FACA status would allow recommendations to flow directly, as in the past, from the subcommittees to the Directors. **The SScAC believes that FACA status is a valuable and important aspect of the advisory process and recommends that OSS charter the SScAC subcommittees as FACA committees.**

Gravity Probe B (GP-B)

The SScAC heard from A&P Director Anne Kinney and from SEUS Chair Rocky Kolb about the most recent problems with the Gravity Probe B (GP-B) mission. We endorse the A&P plans to scrutinize closely the status and prospects of GP-B prior to making any additional commitments. It makes good sense to appoint separate technology and science review panels, and to ask them to provide a rapid and unambiguous assessment of GP-B. We recognize that additional cost growth in the program could be large enough to have an impact on the entire Astronomy and Physics program; consequently, it is important that the science panel be broadly representative of the whole space astrophysics community. It should assess the overall science value from a broad perspective keeping in mind the science potential of Beyond Einstein programs such as LISA**. We would like to hear, at our next meeting, a report on the outcome of the panel recommendations regarding GP-B.**

Radioastron

The SEUS brought the issue of the Radioastron mission to the attention of SScAC. During its recent subcommittee meeting, the SEUS heard candid and comprehensive presentations from Ed Fomalont and Jeff Hayes regarding the Radioastron scientific goals and mission development. The SEUS was tasked to consider the potential scientific payoff of Radioastron in light of the anticipated cost. **SScAC and the SEUS are hopeful that the Russian space program will thrive as a partner in future international space astrophysics programs, but for the Radioastron mission we believe that the science payoff does not warrant the cost.**

Project Prometheus

This program combines several on-going technology development initiatives under one umbrella within the SSE theme: radioisotope power system, nuclear electric power, and

nuclear propulsion system. SScAC remains strongly committed to the development of nuclear space power and propulsion systems that greatly expand the reach and capabilities of future space science missions. The committee, therefore, welcomes the Congressional support in the FY03 budget.

We recommend that Code S aggressively engage the *broad* space science community in exploring the opportunities provided by this new program. Some mechanisms may include more information dissemination, workshops, NRA concept studies, etc. This should result in the identification of missions in ***all thematic areas*** that would benefit from these developing technologies (indeed such technologies may enable missions previously thought to be in the realm of science fiction, or at least in the realm of unrealistically large budgets).

To succeed, Project Prometheus will draw upon a highly distributed set of assets and capabilities at DOE and NASA's national labs, universities, and industry sites. Compared to traditional space science projects, Project Prometheus is more complex. "Getting it right" at the front end of this project is critical to the long-term viability of the advanced technology initiative and the subsequent success of the space missions. **Thus, SScAC recommends that as much attention should be given to the management plan as is given to the technology plan. Furthermore, the SScAC is willing to assist in an advisory role and would be pleased to appoint a task force staffed with individuals qualified to oversee the early stages of Project Prometheus.**

JIMO

The Jupiter Icy Moons Orbiter (JIMO) has been identified as the inaugural mission in the Prometheus Project. The committee applauds the Congressional support in the FY03 budget for the first increment of funding for the JIMO mission. SScAC is pleased at this explicit linkage of technology development with an identified science mission. This will focus the early stages of the advanced technology plan and spur the timely development of mission-critical flight hardware. The JIMO mission is fully aligned with the recommendations of the Decadal Survey for Solar System Exploration, which listed a mission to Europa as the top "flagship" mission. JIMO should reflect the Decadal Survey's recommendation for the necessary investment in capabilities, tools, techniques, personnel, and supporting research to ensure maximum scientific return from the mission. **At a future meeting, SScAC would like to hear how the implementation plan responds to the Decadal Survey investment recommendation.**

James Webb Space Telescope (JWST)

The SScAC acknowledges the highest priority given to JWST by the 2000 Astronomy and Astrophysics Survey – JWST is the Hubble Space Telescope of the next decade. The SScAC believes that the scope of the JWST mission is commensurate with its central role in the Origins theme and notes that JWST will make important contributions to the SEU and SSE themes as well.

Alan Dressler reported concerns raised by the Origins Subcommittee regarding the JWST replanning effort, which was described to SScAC by Anne Kinney. The OS has reaffirmed its unanimous opinion that inclusion of the MIRI instrument, which gives a broad infrared wavelength capability to JWST and enables both important science and an unparalleled sensitivity compared to current and anticipated space- and ground-based telescopes, is essential for a successful mission.

Since no solution that maintains this science scope for JWST has been found within the desired budget and funding profile, the OS agrees with Anne Kinney that the replan process has not yet succeeded. SScAC supports a solution that prevents a major loss of science capability from the JWST. **The SScAC joins the OS in supporting its recommendation that the process be continued to find a successful outcome.**

Small Paylad Launch Capability

Several recent reports and plans stress the fact that "access to space at a reasonable cost" for space science payloads is a fundamental issue. The SScAC appreciates the review of launch assets that has been conducted by Karen Poniatowski (Code M) on behalf of the space science community and the initial steps taken to proactively deal with this issue. The extended buy of Delta IIs, assessment of DoD assets, and the request for a waiver to fly on a foreign vehicle are positive steps. However, there is a great deal of uncertainty as to the future availability of small and medium sized launchers for space science payloads due to the lack of demand by DoD and commercial firms for these vehicles. The availability of small launch vehicles and the launch rate required to maintain a healthy manufacturing capability remains a concern that extends beyond the five-year time span for which reasonable predictions can be made.

As NASA further assesses its options and makes inputs to the Administration's revised National Space Transportation Policy, **the SScAC recommends the Agency maintain its commitment to assured access to space for all classes of space science missions and be open to innovative policy and procurement options in support of this goal.**

This issue was brought before the NASA Advisory Council at the March 03 meeting. It was deemed an important issue for their consideration. The NAC plans to obtain additional presentations and information before making a formal recommendation to NASA management.

Education and Public Outreach

At this meeting the SScAC reviewed and discussed the Report of the EPO Task Force. The Committee endorses the Report, thanks the Task Force for its work, and is pleased to transmit the findings and recommendations to the Office of Space Science for its consideration (see attached Report). SScAC was pleased to learn about the substantial progress the EPO program has made over the past six years. It is clear that the EPO Program has taken an innovative, process-oriented approach that has achieved many successes.

At this time, the SScAC finds that the start-up phase of the EPO Program is complete and it is ready to move to the next level of maturity. **SScAC endorses the specific recommendations presented in the Task Force Report to improve the effectiveness of an already successful program.** We want to call special attention to the need to provide greater coherence and accessibility for its educational products; to reach out more aggressively to serve other audiences like community colleges, undergraduates, and pre-service teachers; and to strengthen and expand professional development efforts for EPO professionals, educators and scientists.

SScAC hopes that the OSS E/PO program could serve as a model for future NASA educational efforts. This Committee has previously expressed its concerns about the potential impact of the new Office of Education on the OSS EPO Program (see previous letter from SScAC Chair). We urge the OSS management to be proactive in this regard and help the Office of Education in establishing programs.

The SScAC shares the concern expressed in the Task Force Report regarding the role of Code N in the OSS E/PO activities and noted by the NASA Advisory Council at its March 03 meeting.

Research and Analysis

A number of SScAC members asked questions about the R&A program at different points during the meeting. R&A remains a particularly important element of the OSS budget for the scientific utilization of its diverse mission by the science community. As the meeting developed the SScAC came to realize that we did not have a broad understanding of the extent of the R&A program in each of the Divisions.

SScAC requests a detailed briefing on the R and A budget to better understand the breath of R and A activities and budgets within OSS.

Sincerely,

Andrew B. Christensen
SScAC Chair

c. Dr. Mark Allen, Director for Strategic and International Planning
Space Sciences Advisory Committee
Dr. Anne Kinney, Director, Astronomy and Physics Division
Dr. Charles Kennel, Chair, NASA Advisory Council
Dr. Richard Fisher, Director, Sun Earth Connection Division
Dr. Colleen Hartman, Director, Solar System Exploration Division
Dr. Orlando Figueroa, Director, Mars Exploration Program
Dr. Jeff Rosendahl, Director for Education and Public Outreach
Ms. Marian Norris, Management Support Specialist

Attachments:

SESS meeting Report
OS meeting Report
SECAS Meeting Report
SEUS Meeting Report
E/PO Final Report

SPACE SCIENCE ADVISORY COMMITTEE (SScAC)
NASA Headquarters, Washington, DC
March 3-5, 2003

1) FY 2004 Budget Presentation [Weiler]
2) Astronomy and Physics Division Report [Kinney]
3) Launch Services Outlook [Poniatowski]
4) SEUS Report [Kolb)
5) Project Prometheus Program [Newhouse]
6) Solar System Exploration Division Report [Hartman]
7) Mars Program Office Report [Figueroa]
8) Origins Report [Dressler]
9) Space Science Enterprise Strategy [Allen/May]
10) Education Task Force Report [Knappenberger]
11) Sun-Earth Connection Division Report [Fisher]